

REMARKS

By this amendment, applicants have canceled non-elected claims 7-9 without prejudice or disclaimer.

Since the foregoing amendments merely cancel claims, entry of this amendment under 37 CFR 1.116 is requested.

Claims 1, 6 and 10 stand rejected under 35 U.S.C. 103(a) as being unpatentable over JP 2001-85006 in view of WO03/044881. Applicants traverse this rejection and request reconsideration thereof.

Claims 1 and 6 relate to a positive electrode material and claim 10 to a lithium secondary battery including a positive electrode made of the positive electrode material according to claim 1. The positive electrode material of the present invention includes plural primary particles flocculated to form a secondary particle, wherein the length in which the primary particles are linked on the section of the secondary particle is equivalent to 10 to 70% of the length of the whole periphery of the section of the primary particles. The secondary particle is represented as $\text{Li}_a\text{Mn}_x\text{Ni}_y\text{Co}_z\text{O}_2$, and the secondary particle is composed of crystals having layer structure of composite oxide meeting $1 \leq a \leq 1.2$, $0 \leq x \leq 0.65$, $0.35 \leq y < 0.5$, $0 \leq z \leq 0.65$ and $x+y+z=1$.

A first feature of the present invention is that the "length in which the primary particles are linked on the section of the secondary particle is equivalent to 10 to 70% of the length of the whole periphery on the section of the primary particles." As described on page 4, lines 1-8 of Applicants' specification, the ionic conductivity of an electrolytic solution is deteriorated at low temperature. If each secondary particle of positive electrode material is formed with flocculated primary particles and the primary particles are positioned apart from one another so that the spaces among the primary particles are filled with electrolytic solution, a conductive network among

the primary particles is locally decreased. Therefore, the resistance increases and the voltage drop of a battery occurs.

On the other hand, by increasing the contact area among primary particles, it is possible to maintain the conductive network in low temperature environment.

Fig. 2 schematically shows that a secondary particle 2 of the positive electrode material is formed with flocculated primary particles 1. For the cross section of each primary particle, the total length of the shared sides with the adjoining primary particles is calculated and compared with the length of the periphery of the primary particle. The desirable average of such contact length compared with the periphery of the section of the primary particle is 10 to 70%, as presently claimed.

Japanese Patent Publication 2001-85006 (Nakano) discloses a lithium-nickel composite oxide for a lithium secondary battery positive electrode active material and a lithium secondary battery. Generally, a lithium nickel complex oxide changes its particulate structure due to expansion and contraction at charging and discharging. The secondary particle is decomposed into primary particles by repeated charging and discharging. The electron conductivity of the active material decreases and the internal resistance increases to cause the capacity of the lithium secondary battery to decrease.

According to Nakano, a relatively large size of primary particles is used.

When a secondary particle is decomposed due to charging or discharging, it breaks along the grain boundaries of primary particles. If the particle size of primary particle is small, the secondary particle is decomposed into fine particles and the electronic conductivity of the primary particles decreases.

However, if the particle size of primary particle is large, it is possible to prevent the secondary particle from being decomposed into fine particles.

Therefore, the electronic conductivity of the primary particles does not decrease.

The high electronic conductivity of the positive electrode can be maintained, though charging and discharging are repeated.

According to the present invention, it is not necessary to use a relatively large size of primary particles, but is necessary that the average length of the contact area of the primary particle is equivalent to 10 to 70% of the average length of the periphery of the primary particle on the section of a secondary particle.

Since Nakano uses relatively a large size of primary particles, the inner primary particles can have relatively large contact area, but the outer primary particles can have only relatively small contact area. Accordingly, Nakano cannot achieve the first feature of the present invention.

Nakano uses a relatively large size of primary particles, but does not disclose any condition regarding the contact area among the primary particles. Therefore, Nakano cannot achieve the first feature of the present invention.

Comparing Fig. 1 of Nakano with Fig. 2 of the present application, it is easy to distinguish the contact area of the present invention with that of Nakano. It seems that the contact area of the primary particles in the secondary particle in Fig. 1 of Nakano may be less than 10%.

A second feature of the present invention is in that the secondary particle is represented as $\text{Li}_a\text{Mn}_x\text{Ni}_y\text{Co}_z\text{O}_2$; and the secondary particle is composed of crystals having layer structure of composite oxide meeting $1 < a \leq 1.2$, $0 \leq x \leq 0.65$, $0.35 \leq y < 0.5$, $0 \leq z \leq 0.65$ and $x + y + z = 1$. In other words, the second feature of the present invention is in that the percentage content of Ni (y) is less than 50%, so that the relative lattice volume change rate decreases. See page 15, lines 23-34 of Applicants' specification.

Fig. 7 shows that if the percentage content of Ni is 50% or less, the change of lattice volume due to charging/discharging decreases. Therefore, it is possible to maintain the high contact area among the primary particles, and the high capacity maintenance rate.

However, according to Nakano, the content of Ni is more than 50%, and therefore, the material of Nakano cannot maintain the high contact area of primary particles. Therefore, a change of lattice volume due to charging/discharging occurs, resulting in the decomposition of secondary particles. Accordingly, Nakano cannot maintain high electron conductivity and cannot achieve an improvement of the capacity maintenance rate.

Since Nakano does not teach the contact area of primary particles, the present invention would not have been obvious to one of ordinary skill in the art.

WO 03/044881 (Shiozaki) discloses a positive electrode active material for a lithium secondary cell. The object of Shiozaki is to obtain a high energy density and an excellent charging/discharging performance in a positive electrode active material for a lithium secondary cell. On the other hand, the object of the present invention is to obtain a high discharge rate characteristic and a high battery capacity in the environment of the low temperature of -30°C in positive electrode material and a lithium secondary battery.

The object of the present invention is different from that of Shiozaki.

Moreover, Shiozaki does not teach the contact area among primary particles in each second particle as presently claimed.

Since the object of Shiozaki is different than that of the present invention, it is submitted there would have been no reason for one of ordinary skill in the art to have modified the teachings of Nakano based on those of Shiozaki. Moreover, since neither Nakano nor Shiozaki discloses the presently claimed length in which

the primary particles are linked on the section of the secondary particles, even of the combined teachings of Nakano and Shiozaki would not have suggested the presently claimed invention.

In view of the foregoing amendments and remarks, entry of this amendment and favorable reconsideration and allowance of all of the claims now in the application are requested.

To the extent necessary, applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 1021.43559X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

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